CLAIMS

What is claimed is:

1. A pump comprising:

a housing having a first chamber and a second chamber, the first chamber having a first inlet and a first outlet, the second chamber having a second inlet and a second outlet, the second inlet being in communication with the first outlet of the first chamber;

a first piston positioned within the first chamber;

a second piston positioned within the second chamber and secured to the first piston, the first and second pistons each having a diameter, the diameter of the first piston being larger than the diameter of the second piston; and

a drive system for reciprocating the first and second pistons in unison within the first and second chambers such that when the first piston is moving in an expansion stroke, fluid can be drawn into the first chamber through the first inlet, and at the same time, the second piston is moving in a compression stroke where fluid can be expelled from the second chamber through the second outlet, and when the first piston is moving in a compression stroke, the second piston is moving in an expansion stroke where fluid can be expelled from the first chamber through the first outlet and into the second chamber through the second inlet.

2. The pump of Claim 1 further comprising a connecting member for securing the first and second pistons together in a spaced apart manner along a common axis, and extending between the first and second chambers.

3. The pump of Claim 2 in which the connecting member includes a threaded screw, the drive system including a rotatable nut engaged with the threaded screw and a reversible motor for alternately rotating the nut in opposite directions, to cause reciprocating linear translation of the connecting member and pistons.

4. The pump of Claim 3 in which the nut is a ball screw nut.

5. The pump of Claim 1 further comprising a check valve system for preventing back flow through the pump.

6. The pump of Claim 5 in which the check valve system comprises a first check valve for preventing fluid from exiting the first chamber through the first inlet.

7. The pump of Claim 6 in which the check valve system further comprises a second check valve for preventing fluid from exiting the second chamber through the second inlet.

8. The pump of Claim 7 in which the check valve system further comprises a third check valve for preventing fluid from entering the second chamber through the second outlet.

9. The pump of Claim 1 further comprising a piston position sensing system.

10. The pump of Claim 1 further comprising a first pressure sensor for sensing pressure in the first chamber.

11. The pump of Claim 10 further comprising a second pressure sensor for sensing pressure of fluid expelled from the second chamber.

12. The pump of Claim 1 in which the diameters of the first and second pistons have a difference in size of about a 3.5 to 1 ratio.

13. The pump of Claim 12 in which the first and second pistons have a stroke of about 6 inches.

14. The pump of Claim 13 in which the pump is capable of pumping about .5 $in.^3$ of gas at about 2200 psi per cycle.

15. A pump comprising:

a housing having a first chamber and a second chamber, the first chamber having a first inlet and a first outlet, the second chamber having a second inlet and a second outlet, the second inlet being in communication with the first outlet of the first chamber;

a first piston positioned within the first chamber;

a second piston positioned within the second chamber and secured to the first piston, the first and second pistons each having a diameter, the diameter of the first piston being larger than the diameter of the second piston;

a connecting member for securing the first and second pistons together in a spaced apart manner along a common axis, and extending between the first and second chambers, the connecting member including a threaded screw;

a drive system for reciprocating the first and second pistons in unison within the first and second chambers such that when the first piston is moving in an expansion stroke, fluid can be drawn into the first chamber through the first inlet, and at the same time, the second piston is moving in a compression stroke where fluid can be expelled from the second chamber through the second outlet, and when the first piston is moving in a compression stroke, the second piston is moving in an expansion stroke where fluid can be expelled from the first chamber through the first outlet and into the second chamber through the second

inlet, the drive system including a rotatable ball screw nut engaged with the threaded screw and a reversible motor for alternately rotating the nut in opposite directions to cause reciprocating linear translation of the connecting member and pistons; and

a check valve system for preventing back flow through the pump.

16. The pump of Claim 15 in which the check valve system comprises a first check valve for preventing fluid from exiting the first chamber through the first inlet.

17. The pump of Claim 16 in which the check valve system further comprises a second check valve for preventing fluid from exiting the second chamber through the second inlet.

18. The pump of Claim 17 in which the check valve system further comprises a third check valve for preventing fluid from entering the second chamber through the second outlet.

19. The pump of Claim 15 further comprising a piston position sensing system.

20. The pump of Claim 15 further comprising a first pressure sensor for sensing pressure in the first chamber.

21. The pump of Claim 20 further comprising a second pressure sensor for sensing pressure of fluid expelled from the second chamber.

22. The pump of Claim 15 in which the diameters of the first and second pistons have a difference in size of about a 3.5 to 1 ratio.

23. The pump of Claim 22 in which the first and second pistons have a stroke of about 6 inches.

24. The pump of Claim 23 in which the pump is capable of pumping about .5 $in.^3$ of gas at about 2200 psi per cycle.

25. A method of pumping fluid comprising:

positioning a first piston within a first chamber in a housing, the first chamber having a first inlet and a first outlet;

positioning a second piston within a second chamber in the housing, the first and second pistons being secured to each other and each having a diameter, the diameter of the first piston being larger than the diameter of the second piston, the second chamber having a second inlet and a second outlet, the second inlet being in communication with the first outlet of the first chamber; and

reciprocating the first and second pistons in unison within the first and second chambers with a drive system such that when the first piston is moving in an expansion stroke, fluid is drawn into the first chamber through the first inlet, and at the same time, the second piston is moving in a compression stroke where fluid is expelled from the second chamber through the second outlet, and when the first piston is moving in a compression stroke, the second piston is moving in an expansion stroke where fluid is expelled from the first chamber through the first outlet and into the second chamber through the second inlet.

26. The method of Claim 25 further comprising securing the first and second pistons together in a spaced apart manner along a common axis with a connecting member extending between the first and second chambers.

27. The method of Claim 26 in which the connecting member includes a threaded screw, the drive system including a rotatable nut engaged with the threaded screw, the method further comprising alternately rotating the nut in opposite directions with a reversible motor to cause reciprocating linear translation of the connecting member and pistons.

28. The method of Claim 27 further comprising rotating a ball screw nut.

29. The method of Claim 25 further comprising preventing back flow through the pump with a check valve system.

30. The method of Claim 29 further comprising preventing fluid from exiting the first chamber through the first inlet with a first check valve of the check valve system.

31. The method of Claim 30 further comprising preventing fluid from exiting the second chamber through the second inlet with a second check valve of the check valve system.

32. The method of Claim 31 further comprising preventing fluid from entering the second chamber through the second outlet with a third check valve of the check valve system.

33. The method of Claim 25 further comprising sensing piston position with a piston position sensing system.

34. The method of Claim 25 further comprising sensing pressure in the first chamber with a first pressure sensor.

35. The method of Claim 34 further comprising sensing pressure of fluid expelled from the second chamber with a second pressure sensor.

36. The method of Claim 25 further comprising forming the diameters of the first and second pistons to have a difference in size of about a 3.5 to 1 ratio.

37. The method of Claim 36 further comprising providing the first and second pistons with a stroke of about 6 inches.

38. The method of Claim 37 further comprising pumping about .5 $in.^3$ of gas at about 2200 psi per cycle.

39. A method of pumping fluid comprising:

positioning a first piston within a first chamber in a housing, the first chamber having a first inlet and a first outlet;

positioning a second piston within a second chamber in the housing, the first and second pistons being secured to each other and each having a diameter, the diameter of the first piston being larger than the diameter of the second piston, the second chamber having a second inlet and a second outlet, the second inlet being in communication with the first outlet of the first chamber;

securing the first and second pistons together in a spaced apart manner along a common axis with a connecting member extending between the first and second chambers, the connecting member including a threaded screw;

reciprocating the first and second pistons in unison within the first and second chambers with a drive system such that when the first piston is moving in an expansion stroke, fluid is drawn into the first chamber through the first inlet, and at the same time, the second piston is moving in a compression stroke where fluid is expelled from the second chamber through the second outlet, and when the first piston is moving in a compression stroke, the second piston is moving in

an expansion stroke where fluid is expelled from the first chamber through the first outlet and into the second chamber through the second inlet, the drive system including a rotatable ball screw nut engaged with the threaded screw and a reversible motor for alternately rotating the nut in opposite directions to cause reciprocating linear translation of the connecting member and pistons; and

preventing back flow through the pump with a check valve system

40. The method of Claim 39 further comprising preventing fluid from exiting the first chamber through the first inlet with a first check valve of the check valve system.

41. The method of Claim 40 further comprising preventing fluid from exiting the second chamber through the second inlet with a second check valve of the check valve system.

42. The method of Claim 41 further comprising preventing fluid from entering the second chamber through the second outlet with a third check valve of the check valve system.

43. The method of Claim 39 further comprising sensing piston position with a piston position sensing system.

44. The method of Claim 39 further comprising sensing pressure in the first chamber with a first pressure sensor.

45. The method of Claim 44 further comprising sensing pressure of fluid expelled from the second chamber with a second pressure sensor.

46. The method of Claim 39 further comprising forming the diameters of the first and second pistons to have a difference in size of about a 3.5 to 1 ratio.

47. The method of Claim 46 further comprising providing the first and second pistons with a stroke of about 6 inches.

48. The method of Claim 47 further comprising pumping about .5 $in.^3$ of gas at about 2200 psi per cycle.